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Evaluation of Quality of Vermicompost Prepared from Different Crop Residues

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ABSTRACT

A pot culture experiment on, "Evaluation of quality of vermicompost prepared from different crop residues" was conducted at Division of Soil Science and Agricultural Chemistry, College of Agriculture, Kolhapur with seven treatments replicated thrice in Completely Randomized Design. The crop residues viz. sugarcane trash, maize straw, wheat straw, paddy straw, sorghum straw, pearl millet straw and vegetable market waste were used for vermicomposting by adopting standard method of vermicomposting. The experimental findings indicated that the vermicompost prepared from vegetable market waste required significantly the lowest number of days (46) for vermicomposting which was followed by sugarcane trash (60). The maize straw required significantly more period (75) than other crop residues. The periodical chemical analysis carried during vermicomposting indicated decrease in organic carbon and increase in nutrient content with the advancement of vermicomposting. The significantly higher values of N, P, K and S content and Zn, Mn, Fe and Cu and microbial population were recorded in vermicompost prepared from vegetable market waste followed by sugarcane trash. The study indicated that vegetable market waste was quite superior in respect of period required for vermicomposting and the quality of vermicompost as compared to the vermicomposts prepared from other crop residues.

KEYWORDS Vermicomposting, C/N ratio, micronutrients, microbial population

Vermicomposting is an appropriate technique for the disposal of nontoxic solid and liquid organic wastes. It helps in cost effective and efficient recycling of crop residues and animal excreta like cattle dung. A big problem is of vegetable market waste in the urban area. The disposal of kitchen waste and weekly market waste is really a headache to Municipal Corporation. The vermicompost obtained from vegetable residues contained highest amount of organic matter, N, P, K, Fe, Mn, Cu, and Zn. Vermicompost which is obtained from processing the partially degraded organic matter by the exotic species of earthworm which contains good amount of nutrients and beneficial microflora and biomolecules. It is well establish fact that the use of Vermicompost @ 2.5 t ha-1 saves the use of chemical fertilizer by 25 to 50 percent in different crops.

Material and Methods

The present investigation was undertaken to study the quality of vermicompost prepared from different crop residues at Division of Soil Science and Agricultural Chemistry, College of Agriculture, Kolhapur during 2014. The earthen pots of 10 Kg capacity were used for preparation of vermicompost. Three Kg chopped (3-5 cms) crop residues of sugarcane trash, maize straw, wheat straw, paddy straw, sorghum straw, pearl millet straw and vegetable market waste were mixed with cow dung in 3:1 proportion and allowed to predecompose before releasing the earthworm in the pot. The earthworm species Eudrilus eugenia was used for vermicomposting @ 20 per pot of crop residue. The samples were drawn at 0, 30, 60 days and at the end of vermicomposting and analyzed. Total organic C content in different vermicomposts was determined by using dry ashing method (Gorsuch 1970). The N content (%) in the vermicompost sample was determined by micro-Kjeldahl digestion and distillation method after destroying the organic matter using H_2SO_4 and H_2O_2 (Parkinson and Allen 1975). The P content (%) in the vermicompost sample was determined by vanadomolybdate yellow colour colorimetry metod (Piper 1966). The K content (%) in the vermicompost sample was determined by using flame photometry method (Chapman and Pratt 1961). The micronutrients (Zn, Mn, Fe & Cu) in the vermicompost sample was determined by using atomic absorption spectrophotometery method (Zaroski and Burau 1977). The microbial population (bacteria, fungi and actinomycetes) in the vermicompost sample was determined by using serial dilution plate method (Dhingra and Sinclair 1993).

Results and Discussion

Organic carbon (%), total nitrogen content (%) and C:N ratio at periodical stages of vermicomposting of different crop residues

Total organic carbon (TOC): The data (table 1) indicated that the TOC content of all the crop residues showed decreasing trend during vermicomposting. The TOC content during vermicomposting varied from 35.00 (paddy straw) to 46.00% (vegetable market waste) on 0th day, while on at the end of vermicomposting it ranged from 16.65 (maize straw) to 23.21% (vegetable market waste). Total organic C content decreased with the decomposition during vermicomposting in all the organic residues which might be due to loss of C as CO_2 through microbial respiration and mineralization of organic matter causing increase in total N. It is reported that part of the C in the decomposing residues released as CO_2 and part was assimilated by the microbial biomass, microorganisms used the C as a source of energy and decomposing the organic matter (Pattnaik and Reddy 2010). Gradual decrease in organic carbon during vermicomposting might be due to the biological oxidation of carbonaceous material present in organic wastes during decomposition. Similar observations were noted by Prabha et.al. (2008).

Total nitrogen (TN): The total N content of all the crop residues showed increasing trend during vermicomposting (Table

1). The increases in total N content during vermicomposting from 0 days to at the end of vermicomposting were 0.46 to 1.10% (sugarcane trash), 0.54 to 0.98% (maize straw), 0.56 to 1.12% (wheat straw), 0.44 to 0.84% (paddy straw), 0.72 to 1.15% (sorghum straw), 0.58 to 1.22% (pearl millet straw) and 1.14 to 1.52% (vegetable market waste). In vermicomposting higher total N content was recorded in vegetable market waste and minimum N content in paddy straw at all stages of vermicomposting. The increase in total N content during vermicomposting could be due to manifestation of organic fractions. The rapid increase in total N content in vermicomposting could be due to high mineralization of organic matter by microbes and earthworms and excretion of nitrogenous wastes through earthworm body (Rama Lakshmi et al. 2013). Higher N content during vermicomposting of vegetable market waste could be attributed to the higher level of initial N content in the raw material itself. Pattnaik and Reddy (2010) observed gradual increase of total N content of market waste in both vermicomposting and conventional composting from initial to maturity phase and it showed significant temporal variation during decomposition.

Table 1. Total organic carbon (%), total nitrogen content (%) and C:N ratio at periodical stages of vermicomposting of different crop residues

Treatments	Days of vermicomposting											
	Organic carbon (%)				Total N (%)				C:N Ratio			
	0	30	60	At the end of vermi-composting	0	30	60	At the end of vermi-composting	0	30	60	At the end of vermi-composting
T_1 Sugarcane trash	35.20	26.40	18.00	18.00	0.46	0.70	1.10	1.10	76.52	37.71	16.36	16.36 (60)
T Maize straw	38.00	30.17	20.17	16.65	0.54	0.68	0.88	0.98	70.37	44.36	22.92	16.98 (75)
T Wheat straw	44.30	36.17	22.17	18.16	0.56	0.78	1.00	1.12	79.10	46.37	22.17	16.21 (72)
T Paddy straw	35.00	27.41	20.42	17.00	0.44	0.60	0.78	0.84	79.54	45.68	26.17	20.23 (70)
T Sorghum straw	43.40	32.13	23.30	20.99	0.72	0.90	1.12	1.15	60.27	35.70	20.80	18.25 (65)
T Pearl millet straw	45.25	37.93	26.60	21.66	0.58	0.86	1.14	1.22	72.84	44.10	23.33	17.75 (68)
T Vegetable market waste	46.00	35.32	-*	23.21	1.14	1.35	-*	1.52	40.35	26.16	-*	15.26 (46)
SE ±	0.24	0.26	0.30	0.31	0.01	0.02	0.02	0.03	0.20	0.13	0.16	0.16 (0.69)
CD at 5%	0.73	0.79	0.91	0.95	0.02	0.07	0.08	0.08	0.61	0.40	0.51	0.48 (2.09)

Figures in paranthesis indicates days required for vermicomposting and * Vegetable market waste was fully converted to vermicompost at 46^{th} day of vermicomposting

C/N ratio: A perusal of data indicated that the C/N ratio showed declining trend during vermicomposting. The C/N ratio of sugarcane trash, maize straw, wheat straw, paddy straw, sorghum straw, pearl millet straw and vegetable market waste at 0 days of vermicomposting was 76.52, 70.37, 79.10, 79.54, 60.27, 72.84 and 40.35 respectively. At the end of vermicomposting the C/N ratio was further reduced to 16.36, 16.98, 16.21, 20.23, 18.25, 17.75 and 15.26 in sugarcane trash, maize straw, wheat straw, paddy straw, sorghum straw, pearl millet straw and vegetable market waste, respectively. In vermicompost, paddy straw recorded the highest C/N ratio, while vegetable market waste exhibited the lowest C/N ratio. This could be due to respiratory activity of earthworms and microorganisms and increase in total N by mineralization of organic matter and excretion of nitrogenous wastes (Punde and Gonarkar 2012). At all stages of vermicomposting, the lowest C/N ratio was recorded in vegetable market waste which might be due to maximum N content in vegetable market waste as compared to other crop residues and also due to faster decomposition of vegetable market market waste which leads to reduction of C as CO2. Similar results were reported by Mahanta and Jha (2009) and Rama Lakshmi et al. (2013).

Total zinc and manganese content (mg kg-1) at various periodical stages of vermicomposting of different crop residues

Total zinc content: Results obtained in table 2 indicated that the zinc content of all the crop residues showed increasing trend during vermicomposting. The zinc content during vermicomposting varied from 16.27 (paddy straw) to 29.84 mg kg-1 (vegetable market waste) on 0th day, while on at the end of vermicomposting it was ranged between 40.50 (paddy straw) to 63.87 mg kg-1 (vegetable market waste). Present data revealed that the total zinc content increased significantly in the vermicomposts prepared from different crop residues. Among the organic residues, vegetable market waste registered higher zinc content than other organic residues. This might be due to the nature and composition of substrate. These results are in conformity with those reported by Vasanthi and Kumaraswami (1999), Jaykumar et al. (2011), Adhikary (2012) and Rama Lakshmi et al. (2013).

Table 2. Total zinc and manganese content (mg kg-1) at various periodical stages of vermicomposting of different crop residues

Treatments	Days of vermicomposting							
	Zn				Mn			
	0	30	60	At the end of vermicomposting	0	30	60	At the end of vermicomposting
T Sugarcane trash	27.14	40.83	49.23	49.23	24.40	34.15	47.33	47.33
T Maize straw	21.17	34.67	41.50	45.63	18.16	26.07	39.27	45.17
T Wheat straw	19.34	30.53	40.50	43.50	16.18	25.00	33.97	37.97
T Paddy straw	16.27	28.50	35.50	40.50	15.53	23.07	31.47	36.13
T Sorghum straw	22.24	35.13	40.65	42.57	19.20	28.27	35.40	40.20
T Pearl millet straw	24.74	37.53	42.50	44.57	22.17	30.33	37.13	42.15
T_7 Vegetable market waste	29.84	57.47	-*	63.87	33.14	51.27	-*	58.20
SE ±	0.12	0.07	0.26	0.32	0.25	0.32	0.29	0.22
CD at 5%	0.35	0.20	0.80	0.97	0.75	0.97	0.89	0.65

*** Vegetable market waste was fully converted to vermicompost at 46th day of vermicomposting**

Total manganese content: The total manganese content of all the crop residues showed increasing trend during vermicomposting (Table 2). The increases in total manganese content during vermicomposting from 0 days to at the end of vermicomposting were 24.40 to 47.33 mg kg-1 (sugarcane trash), 18.16 to 45.17 mg kg-1 (maize straw), 16.18 to 37.97 mg kg-1 (wheat straw), 15.53 to 36.13 mg kg-1 (paddy straw), 19.20 to 40.20 mg kg-1 (sorghum straw), 22.17 to 42.15 mg kg-1 (pearl millet straw) and 33.14 to 58.20 mg kg-1 (vegetable market waste). While, the rest of all the treatments also showed the increase in total manganese content, as among the organic residues vegetable market waste registered significantly highest micronutrient status than other organic residues. These results are in accordance with those reported by Vasanthi and Kumaraswami (1999), Jaykumar et al. (2011), Adhikary (2012) and Rama Lakshmi et al. (2013).

Total iron content: Results obtained in table 3 indicated that the iron content of all the crop residues showed increasing trend during vermicomposting. The zinc content during vermicomposting varied from 22.20 (paddy straw) to 49.40 mg kg-1 (vegetable market waste) on 0th day, while on at the end of vermicomposting it was ranged between 56.03 (paddy straw) to 87.33 mg kg-1 (vegetable market waste). These results are similar to these reported by Vasanthi and Kumaraswami (1999), Jaykumar et al. (2011), Adhikary (2012) and Rama Lakshmi et al. (2013).

Total copper content: The total copper content of all the crop residues showed increasing trend during vermicomposting (Table 3). The increases in total copper content during vermicomposting from 0 days to at the end of vermicomposting were 14.93 to 28.33 mg kg-1 (sugarcane trash), 9.30 to 24.13 mg kg-1 (maize straw), 11.60 to 23.17 mg kg-1 (wheat straw), 8.96 to 20.90 mg kg-1 (paddy straw), 13.10 to 25.13 mg kg-1 (sorghum straw), 14.24 to 26.60 mg kg-1 (pearl millet straw) and 18.21 to 34.13 mg kg-1 (vegetable market waste). Similar results were reported by Vasanthi and Kumaraswami (1999), Jaykumar et al. (2011), Adhikary (2012) and Rama Lakshmi et al. (2013). They opined that increased micronutrient status in matured vermicompost than initial values might be due to loss of mass during composting and nature and composition of substrates.

Table 3. Total iron and copper content (mg kg-1) at various periodical stages of vermicomposting of different crop residues
*** Vegetable market waste was fully converted to vermicompost at 46th day of vermicomposting.**

Treatments	Days of vermicomposting							
	Fe				Cu			
	0	30	60	At the end of vermicomposting	0	30	60	At the end of vermicomposting
T_1 Sugarcane trash	37.70	51.93	69.00	69.00	14.93	21.40	28.33	28.33
T_2 Maize straw	31.70	52.97	63.93	68.10	9.30	17.93	22.03	24.13
T_3 Wheat straw	25.50	41.90	54.47	65.00	11.60	18.97	21.07	23.17
T_4 Paddy straw	22.20	37.93	47.00	56.03	8.96	15.20	18.10	20.90
T_5 Sorghum straw	29.10	51.03	63.00	74.27	13.10	19.07	23.13	25.13
T_6 Pearl millet straw	39.80	59.93	70.00	76.03	14.24	20.00	23.97	26.60
T_7 Vegetable market waste	49.40	76.33	-*	87.33	18.21	29.10	-*	34.13
SE ±	0.12	0.14	0.15	0.15	0.12	0.11	0.19	0.24
CD at 5%	0.36	0.42	0.46	0.45	0.38	0.34	0.58	0.72

Total organic carbon, Total N, P, K, S and C:N ratio of vermicompost prepared from different crop residues.

The organic carbon, N, P, K, S and C:N ratio of vermicompost prepared from different crop residues varied from 16.65 (maize straw) to 23.21% (vegetable market waste), 0.84 (paddy straw) to 1.52% (vegetable market waste), 0.55 (paddy straw) to 0.79% (vegetable market waste), 0.72 (wheat straw) to 1.74% (vegetable market waste), 0.39 (paddy straw) to 0.62% (vegetable market waste) and 15.26 (vegetable market waste) to 20.23 (paddy straw) presented in Table 4.

Table 4. Organic C, Total N, P, K, S and C:N ratio of vermicompost prepared from different crop residues.

Treatments	Organic C (%)	Total N (%)	Total P (%)	Total K (%)	Total Sulphur (%)	C:N Ratio
T_1 Sugarcane trash	18.00	1.10	0.71	1.54	0.57	16.36
T_2 Maize straw	16.65	0.98	0.65	0.84	0.53	16.98
T_3 Wheat straw	18.16	1.12	0.62	0.72	0.49	16.21
T_4 Paddy straw	17.00	0.84	0.55	0.81	0.39	20.23
T_5 Sorghum straw	20.99	1.15	0.63	0.95	0.48	18.25
T_6 Pearl millet straw	21.66	1.22	0.66	1.32	0.55	17.75
T_7 Vegetable market waste	23.21	1.52	0.79	1.74	0.62	15.26
SE ±	0.31	0.03	0.053	0.015	0.01	0.16
CD at 5%	0.95	0.08	0.16	0.05	0.02	0.48

Suthar and Singh (2008) concluded that the total P was higher in the vermicompost harvested at the end of the experiment compared to that of initial substrate. The results are in close conformity with those of Singh et al. (2014) and Yadav et al (2014). The present findings corroborated to those of Kaviraj and Sharma (2003), who demonstrated the higher K concentration in the end product. They also stated that the increase in potassium of the vermicompost in relation to that of the simple substrate was probably because of physical decomposition of organic matter of waste due to biological grinding during passage through the gut, coupled with enzymatic activity in worm's gut, which may have caused its increase. Similar results were reported by Rama Lakshmi et al. (2013), Singh et al. (2014), Jaykumar et al. (2011), Mane and Raskar (2012) and Tripathi et al. (2014).

Total microbial count of vermicompost prepared from different crop residues:

The vermicompost prepared from vegetable market waste had significantly higher microbial population of bacteria (28 x107 cfu g-1), fungi (19 x 105 cfu g-1) and actinomycetes (11 x 104 cfu g-1) followed by sugarcane trash. However, the significantly lowest bacteria (20 x 107 cfu g-1) were recorded in paddy straw while and fungi (13 x 105 cfu g-1), and actinomycetes (6 x 104 cfu g-1) population were recorded in the vermicompost prepared from wheat straw (Table 5).

Table 5: Total microbial count of vermicompost prepared from different crop residues

Treatments	Population count (cfu g^{-1})		
	Bacteria $x10^7$	Fungi $x10^5$	Actinomycetes $x10^4$
T_1 Sugarcane trash	26.00	18.00	10.00
T_2 Maize straw	23 .00	16.00	7.00
T_3 Wheat straw	21 .00	13.00	6.00
T_4 Paddy straw	20 .00	15.00	7.00
T_5 Sorghum straw	24 .00	17.00	8.00
T_6 Pearl millet straw	25 .00	16.00	9.00
T_7 Vegetable market waste	28 .00	19.00	11.00
SE ±	0.58	0.48	0.52
CD at 5%	1.75	1.44	1.58

The fungi breakdown debris and helps the bacteria to fasten the decomposition process. Most of the fungi reside in the periphery of the vermicompost bed and their increased number is in accordance with faster decomposition of organic residues. The significantly increased level of microbial population and its activity in the vermicompost might be due to the higher nutrient concentration in the substrate and cast, multiplication of microbes while passing through the gut of worms, optimal moisture and large surface area of casts ideally suited for better feeding, multiplication and activity of microbes (Anbalagan and Manivannam, 2012) and Esakkiammal et al. (2015). Among the various crop residues used for preparation of vermicompost, the vegetable market waste was quite superior in respect of period required for vermicomposting and the quality of vermicompost as compared with all other crop residues.

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